Topics to review for Midterm #3:

Light and EM Radiation:

- EM radiation is a periodic modulation of the electric field: travels as a wave
- Wavelength (or frequency) determines:
  - type of EM radiation
  - if in visible range, wavelength determines color of light
- Spectrum of a source : plot of EM power (or intensity) emitted as a function of l
- White light:
  - Light appears white when it contains all visible colors at roughly equal intensity
  - Technically defined as the spectrum of light emitted from sun

c = speed of light = $\nu\lambda$ = frequency x wavelength

Blackbody:

- Everything that has a non-zero temp emits a spectrum of EM radiation
- The spectrum of EM radiation from a black object is "blackbody spectrum."
- Black object: Absorbs and emits all EM easily
- Go to the blackbody spectrum simulation
- BB spectrum determined by temperature only.
- The temperature of the object affects both
  - The total power of EM radiation emitted by the object
  - The range of wavelengths emitted (the spectrum)

Power = e σ T^4 a

As T increases - Power at all λ increases

- Proportionally more power at shorter l
- λ_{peak} shifts to shorter λ ($\propto 1/T$)

Atoms / electric charge and electric Force:

Atoms have equal number of protons and electrons, so total charge is *zero.*

$\Rightarrow$*They are electrically neutral*

The same is true of most ordinary objects (made of atoms.)

You can pull electrons off atoms. This leaves 2 *charged* particles :

- Unbound (free) electrons (negatively charged)
- Positively charged ions

(ion = atom with unequal number of protons and electrons)

charge of electron & proton = e = 1.6×10^{-19} Coulombs (C) unit of charge

Opposite charges attract; likes repel (according to:

$$\mathbf{Force_{of\ B\ on\ A} = \frac{kq_Aq_B}{r^2}}$$

Can also polarize neutral objects where + and – separate within the material,

→ under right conditions, neutral objects can be attracted to charged.

Voltage:

Tells you what charges will do/ describes forces on + charges…

EPE = q ΔV, where q = charge of object and ΔV is voltage difference

Like GPE with q ↔ m and $\Delta V \leftrightarrow \Delta h$

Voltage (V)

- tells you EPE of any charge at that location in space
- Tells you work required to bring a unit charge from V = 0 to that location
- Determined by surrounding charges.
  Closer you are to + charge the more + the voltage
- A grounded object is always at V = 0
- Usually most interested in DV: voltage difference between 2 locations

Circuits:

Wires: Make complete circuit necessary for steady flow of electrons
Usually have negligible (zero) resistance

Battery: Has positive charges piled up at one terminal and negative charges at the other
Provides voltage difference ΔV around circuit
Provides each electron with q ΔV= eV of EPE to spend in circuit
Provides push for electrons around circuit (bigger V, bigger push)

Bulb: Filament is a high resistance wire in which electrons lose their energy as heat
Think like electron:

a) no electron deaths/births
b) no passing of electrons
c) electrons have energy
(high at start , low at end)
d) Material has resistance
(lets electrons pass easily or not)

Resistance (R) of a circuit element is measure of how hard it is for electrons to pass through. Units: Ohms (Ω)

Current (I) : charge per second flowing past a point in the circuit
(= # electrons per second × charge on electron) Units : Amps (1 A = 1 C/s)

Voltage (difference) (ΔV)

a) **Across battery:** Measure of EPE given to each e^- as it passes through battery. EPE given = eV. Related to pushing force on electrons in circuit
b) **Across a resistor (wire, filament etc):** Measure of EPE lost by each e^- as it passes through. EPE lost = eV.

Ohm's Law: $\Delta V = IR$ (for individual elements)
Power in elements / circuit: $P = I \Delta V$

Batteries can add voltage one to the next.